Toward Efficient and Secure Public Auditing for Dynamic Big Data Storage on Cloud

by

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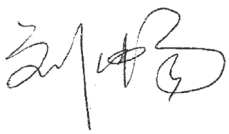
To my family and friends

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Chang Liu



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Abstract

Cloud and Big Data are two of the most attractive ICT research topics that have emerged in recent years. Requirements of big data processing are now everywhere, while the pay-as-you-go model of cloud systems is especially cost efficient in terms of processing big data applications. However, there are still concerns that hinder the proliferation of cloud, and data security/privacy is a top concern for data owners wishing to migrate their applications into the cloud environment. Compared to users of conventional systems, cloud users need to surrender the local control of their data to cloud servers. Another challenge for big data is the data dynamism which exists in most big data applications. Due to the frequent updates, efficiency becomes a major issue in data management. As security always brings compromises in efficiency, it is difficult but nonetheless important to investigate how to efficiently address security challenges over dynamic cloud data.

Data integrity is an essential aspect of data security. Except for server-side integrity protection mechanisms, verification from a third-party auditor is of equal importance because this enables users to verify the integrity of their data through the auditors at any user-chosen timeslot. This type of verification is also named 'public auditing' of data. Existing public auditing schemes allow the integrity of a dataset stored in cloud to be externally verified without retrieval of the whole original dataset. However, in practice, there are many challenges that hinder the application of such schemes. To name a few of these, first, the server still has to aggregate a proof with the cloud controller from data blocks that are distributedly stored and processed on cloud instances and this means that encryption and transfer of these data within the cloud will become time-consuming. Second, security flaws exist in the current designs. The verification processes are insecure against various attacks and this leads to concerns about deploying these schemes in practice. Third, when the dataset is large, auditing of dynamic data becomes costly in terms of communication and storage. This is especially the case for a large number of small data updates and data updates on

multi-replica cloud data storage.

In this thesis, the research problem of dynamic public data auditing in cloud is systematically investigated. After analysing the research problems, we systematically address the problems regarding secure and efficient public auditing of dynamic big data in cloud by developing, testing and publishing a series of security schemes and algorithms for secure and efficient public auditing of dynamic big data storage on cloud. Specifically, our work focuses on the following aspects: cloud internal authenticated key exchange, authorisation on third-party auditor, fine-grained update support, index verification, and efficient multi-replica public auditing of dynamic data. To the best of our knowledge, this thesis presents the first series of work to systematically analysis and to address this research problem. Experimental results and analyses show that the solutions that are presented in this thesis are suitable for auditing dynamic big data storage on cloud. Furthermore, our solutions represent significant improvements in cloud efficiency and security.

The Author's Publications

Book Chapters:

1. **C. Liu**, R. Ranjan, X. Zhang, C. Yang and J. Chen, *A Big Picture of Integrity Verification of Big Data in Cloud Computing*, Handbook on Data Centers (Book), Springer, in press, 2014.

2. X. Zhang, **C. Liu**, S. Nepal, C. Yang and J. Chen, *Privacy Preservation over Big Data in Cloud Systems*, Security, Privacy and Trust in Cloud Systems (Book), Springer, in press, ISBN: 978-3-642-38585-8, 2013.

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3. **C. Liu**, R. Ranjan, C. Yang, X. Zhang, L. Wang and J. Chen, *MuR-DPA: Top-down Levelled Multi-replica Merkle Hash Tree Based Secure Public Auditing for Dynamic Big Data Storage on Cloud*, IEEE Transactions on Computers, accepted on 27 October, 2014

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